
APPENDIX H.

Drilling Fluid Monitoring and Remediation for Horizontal Directional Drilling

**Drilling Fluid Monitoring and
Remediation Plan
For
Horizontal Directional Drilling**

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1 PURPOSE OF THE PLAN

This plan is being prepared for Horizontal Directional Drilling (HDD) operations. The purpose of this plan is to establish monitoring and response criteria that will help minimize potential environmental effects of the HDD operation. The HDD operation uses drilling fluid to facilitate the drilling of a bore hole and installation of the bore pipes. The drilling fluid mixture typically consists of water and bentonite clay for fresh water mixtures, attapulgite clay for salt water mixtures, or a clay-free non toxic biodegradable powder for environmentally sensitive applications. In some cases inert, non-toxic loss circulation materials (LCMs) are added to the mixture. Examples of these materials include cotton dust, cotton seed hulls, wood fiber, M-1 mica and cedar fiber.

The drilling fluid is a water-based slurry composed of naturally occurring clay or naturally occurring and synthetic polymers. The clay is insoluble and made up of small particles that function as both a lubricant for the drill pipe and a sealant that fills the pore spaces surrounding the drill hole. The polymer slurry, commonly known as Enviromud, is water soluble and also serves to lubricate and seal the drill hole.

The boring process utilizes the drilling fluid pressure to run the drill motor and to cut through the earth material, to seal off fractures in the formation, to lubricate the bore pipe during installation and return the cuttings to the bore site. The drilling fluid is pumped down the inside of the bore pipe and exits through the drill head. The fluid can then return to the drill site through the space between the outside of the drill pipe and the ground. The fluid returning to the bore site is called "returns".

Typically at the beginning of the drilling process, a large percentage of the drilling fluid returns to the drill site. As the drill progresses, more of the returns are absorbed by the earth or rock formation and are not returned to the drill site. As the drill extends horizontally, returns may gradually cease until a point where a complete loss of returns may occur. At this point, most or all of the drilling fluids will be lost within the subsurface formations. Some may be lost in lateral and subterranean fractures within the formation. It is possible that drilling fluids may reach the surface by following a vertical fracture that comes close enough to the surface that the pressure causes the release of drilling fluid above ground. It is important to understand that a complete loss of returns, is a fairly normal occurrence during HDD operations and does not necessarily mean the drilling fluid is coming to the surface or impacting the marine environment.

A complete and sudden loss of returns is a signal that something more significant may be occurring and to watch closely for a possible surface release. This plan uses the loss of returns or pressure and visual indications, to trigger response and mitigation actions.

A key to controlling a loss of fluids that may reach the surface and limiting a release into waters of the State, including the ocean, is early detection and quick response by the Contractor. This plan will identify the activities to be monitored and appropriate

response actions to be taken to ensure that any release of drilling fluid or LCM materials is minimized. The plan outlines a process of monitoring the drilling fluid in order to identify a loss-of-returns situation and to determine if there is a release to the surface. Specific measures to be taken to reduce the amount and likelihood of surfacing drilling fluid, and other actions to be taken, are included.

2 TRAINING

Prior to the commencement of construction, the Contractor's and engineer's personnel will attend a training session on-site along with an environmental monitor. The training session will cover the following topics:

- the details of this plan,
- the need for environmental protection,
- environmental resources located at or near the site,
- the need to monitor the HDD operation,
- lines of communication,
- lines of authority and responsibility,
- the information the Contractor will need to provide to the environmental monitor and engineering site representative,
- contact names and phone numbers of the appropriate individuals and agencies, and

The Contractor will provide an overview of the drilling operation in their work plan.

3 HDD Monitoring Overview

The objective of the release monitoring program is to quickly identify the release of drilling fluids and determine the size, extent and location of the release. This will be accomplished by monitoring the HDD equipment, drilling fluid pressures and returns, and visual inspection. Visual inspections will be conducted from shore and by vessel by the environmental monitor.

3.1 Monitoring Along the Land Portion of the Directional Drill

On the land portion of the drill, visual inspection of the drill route will be used to look for evidence that drilling fluid has surfaced. The monitor will keep track of the drill head position and will focus visual inspection in this immediate area and in sensitive habitats such as the intertidal zone.

3.2 Monitoring in the Surf Zone

In the near shore surf zone, where the use of a vessel may be precarious, the monitor will continue to perform visual inspection from the shore. A vessel may be used if it can be used safely.

3.3 Monitoring in the Channel

Vessel monitoring is proposed to begin when the drill head reaches beyond the surf zone. Visual monitoring will continue using a vessel similar to a Zodiac to allow the monitor to be positioned near the drill head.

4 RELEASE MONITORING AND OPERATING CONDITIONS

4.1 Overview of HDD Operating Conditions

It is possible that at some point within each bore a partial or complete loss of returns will occur. This loss of returns may be an indication a release of drilling fluid could occur. The following general parameters will be incorporated during the drilling process.

1. Maintain adequate cover between the drill path and surface during the bore, except at entry and exit.
2. Adjust the thickness of the drilling fluid mixture to match the substrate conditions.
3. Closely monitor drilling pressures and penetration rates so use of drilling fluid pressure will be optimum to penetrate the formation.

4.2 Monitoring Conditions

The environmental monitor will conduct monitoring operations in accordance with the following schedule of activities.

The following table presents the operational measures and monitoring measures to be implemented given certain conditions and events.

Table 4.2 Operation and Monitor Measures

Con- dition	Status of Drilling Returns	Operational Measures to be Implemented	Monitoring Operations
1	Normal expected drilling fluid returns.	Standard drilling procedures	<ul style="list-style-type: none"> - Visual inspection of bore path over land. - In channel, visual inspection from shore and by vessel as necessary.
2	Loss of normal expected drilling fluid.	<p>The Contractor will take appropriate measures to attempt to restore returns. These may include:</p> <ul style="list-style-type: none"> - Modifying drilling fluid properties - Modifying pressure and volume - Advance or retreat pipe - Introduce LCMs according to manufacturer's instructions - Installing a "wash-over" pipe - The use of "Enviromud" per manufacturers specifications. 	<ul style="list-style-type: none"> - Visual inspection of bore path over land. - In channel, visual inspection by vessel.
3	Drilling fluid release observed on land or in channel.	<p>Work will temporarily cease to locate and quantify the release as described in the monitoring operation and to determine the most appropriate next step.</p> <p>The Contractor will take appropriate measures to attempt to reduce or eliminate the release. These may include:</p> <ul style="list-style-type: none"> - Modifying drilling fluid properties - Modifying pressure and volume - Advance or retreat pipe - Introduce LCMs according to manufacturer's instructions - Installing a "wash-over" pipe - The use of "Enviromud" per manufacturers specifications. 	<p>Determine the location and extent of the drilling fluid release.</p> <p>Continue with monitoring method that detected the release and:</p> <ul style="list-style-type: none"> - Commence in-water survey, including diver surveys as necessary. - Conduct shoreline survey for wash-up of drilling fluid.

5 RELEASE MONITORING AND OPERATING SCENARIOS

Different monitoring activities will occur depending on the current condition of the drilling operations. The current drilling condition will be categorized as condition 1, 2 or 3 as described in this section.

5.1 Condition 1: Routine Monitoring

Routine monitoring will apply when the drilling operations are proceeding within expected parameters. The routine monitoring will be conducted by the environmental monitor. The Contractor will be responsible for supplying information to the environmental monitor. This information will also be recorded in logs.

5.1.1 Operational Measures to be Implemented

The Contractor shall supply the following information to the environmental monitor at the completion of each joint of pipe:

- Position of the drilling head relative to the drilling point of entry.
- Recording of the total volume of drilling fluid that has been pumped during the drilling operation.
- Comparison of the current total volume of drilling fluid used and the estimated current total volume of returns.
- Equipment breakdowns and repairs.
- Any abnormal drilling fluid pressure at the time of occurrence.
- The type and quantity of drilling fluid components being used.

5.1.2 Release Monitoring

During normal drilling conditions, the type of monitoring necessary will depend on the location of the drill head. Periodic visual inspection along the bore path of the terrestrial portion of the alignment will take place throughout the bore operation. As the bore head advances beyond the waterline monitoring will be conducted from the shore line and from a vessel as appropriate.

5.2 Condition 2: Loss of Normal Expected Returns

5.2.1 Operations Program

This section will apply to the operation when a loss of normal expected returns is encountered. When normal expected returns are lost:

- The Contractor will notify the environmental monitor of the loss of returns.
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- Drilling will cease if conditions indicate that other actions need to be taken in order to allow the Contractor to take those actions.
- The Contractor, in consultation with the environmental monitor and the owner's representative, will determine the appropriate actions to be taken. The Contractor's rationale of implementing the particular measures will be communicated to the environmental monitor and the owner's representative. The measures that may be used include the following:
 - 1) Modifying Drilling Fluid Properties: The Contractor may determine that modification of the drilling fluid properties will aid in restoring the circulation. These modifications can take place in the form of altering the viscosity or gel strength of the drilling fluid.
 - a) Viscosity: Viscosity of the drilling fluid may be adjusted up or down depending on the subsurface formation and materials encountered and other drilling conditions. Typical viscosity will range from 60 to 70 seconds viscosity as measured with a standard Marsh Funnel.
 - b) Gel Strength: The gel strength of the drilling fluid refers to the shear strength of the fluid as it sets. This characteristic can be modified slightly up or down depending on the drilling conditions in an effort to restore returns.
 - 2) Advance or Retreat the Pipe: If returns are lost, the Contractor may elect to advance or retreat the pipe in an effort to restore returns.
 - 3) Introduce LCMs: LCM introduction into the drilling fluid may be desirable at this point. The possibility of success using LCMs to restore returns will depend on the drilling and subsurface conditions at the time. If used, the LCMs will be used according to the manufacturer's recommendations. The supplier of each LCM has determined the most appropriate implementation technique for the material. The Contractor will carefully follow the supplier's recommendations to give the LCMs the best chance for success.
 - 4) Use of a Wash-over Pipe: The contractor may elect to install a wash-over pipe to ensure the drilling fluid will return to the drill site. The wash-over pipe is larger than the drill pipe and is installed through heavily fractured, less competent, or less dense formations. The annulus space between the drill pipe and the wash-over pipe allows the drilling fluid to return to the drill site.
 - 5) Use of "Enviromud": The contractor may choose to use a substitute to bentonite commonly known as "Enviromud". Enviromud is a nontoxic, biodegradable mixture of naturally occurring and synthetic polymers that can be allowed to naturally dissipate. If the contractor chooses to use this or a similar product, it must be used in accordance with the manufacturers specifications.
- If returns are recovered, drilling will continue under Condition 1 status.
- If bentonite drilling fluid is detected being released to the surface, Condition 3 operations will take effect.

5.2.2 Release Monitoring

Once a loss of returns is identified, the environmental monitor will increase visual monitoring efforts. If the drill head has not passed beyond the water line, the environmental monitor will visually inspect on land and at the shore line for a release of drilling fluid.

If the drill head has passed the waterline, the environmental monitor will visually inspect the water from shore if adequate visual inspection can take place from shore. If the drill head is too far off shore to ensure adequate monitoring from the shore, a vessel will be launched and the environmental monitor will continue visual inspections from the vessel. The monitor will focus on the area near the location of the end of the drill pipe and surrounding area.

5.3 Condition 3: Surface Release of Drilling Fluid

This section applies in the case where the bentonite drilling fluid is detected on the channel floor.

5.3.1 Operations Program

Once a drilling fluid release is detected at the surface:

- The Contractor will take the necessary measures to stop or control the release of drilling fluid.
- The Contractor, in consultation with the environmental monitor and owner's representative will determine the appropriate actions to be taken. The Contractor's rationale of implementing the particular measures will be communicated to the environmental monitor and Owner's representative. The measures that may be used include the following:
 - 1) Modifying Drilling Fluid Properties. The Contractor may determine that modification of the drilling fluid properties aid in restoring the circulation. These modifications can take place in the form of altering the viscosity or gel strength of the drilling fluid.
 - a) Viscosity: Viscosity of the drilling fluid may be adjusted up or down depending on the subsurface formation and materials encountered and other drilling conditions.
 - b) Gel Strength: The gel strength of the drilling fluid refers to the shear strength of the fluid as it sets. This characteristic can be modified slightly up or down depending on the drilling conditions in an effort to restore returns.
 - 2) Advance or Retreat the Pipe: The Contractor may elect to advance or retreat the pipe in an effort to restore returns.
 - 3) Introduce LCMs: LCM introduction into the drilling fluid may be desirable at this point. The possibility of success using LCMs to restore returns will depend on the drilling and subsurface conditions at the time. If used, the LCMs will be

used according to the manufacturer's recommendations. The supplier of each LCM has determined the most appropriate implementation technique for the material. The Contractor will carefully follow the supplier's recommendations to give the LCMs the best chance for success.

- 4) Use of a Wash-over Pipe: The contractor may elect to install a wash-over pipe to ensure the drilling fluid will return to the drill site. The wash-over pipe is larger than the drill pipe and is installed through heavily fractured, less competent, or less dense formations. The annulus space between the drill pipe and the wash-over pipe allows the drilling fluid to return to the drill site.
 - 5) Use of "Enviromud": The contractor may choose to use a substitute to bentonite commonly known as "Enviromud". Enviromud is a nontoxic, biodegradable mixture of naturally occurring and synthetic polymers that can be allowed to naturally dissipate. If the contractor chooses to use this or a similar product, it must be used in accordance with the manufacturers specifications.
- During any drilling shut-down period, the Contractor will be permitted to circulate drilling fluid on a two-hour cycle for a period of approximately 15 minutes to prevent the drilling equipment and pipe from seizing.

5.3.2 Release Monitoring

Upon detection of the release of drilling fluid, the status will elevate to Condition 3. The monitoring method that detected the release will be continued, weather and sea conditions permitting.

Once the drilling fluid is detected in the channel and weather and sea conditions permit, the monitoring team will activate the in-water monitoring effort to mark the location of the release with a surface buoy and continue close visual inspection.

6.0 CLEANUP and RESPONSE

The Contractor shall clean-up and remediate the release of drilling fluid. Immediately following detection of a drilling fluid release the following actions will be taken.

6.1 Release in the Channel

- The cleanup crew will be notified and the dive team will be mobilized to the project site. Mobilization is expected to take less than four hours.
- Intensive monitoring of the release area by the survey vessel shall be implemented.

Divers equipped with specialized water lifts (pumps) and filter bags will be used to remove the discharged bentonite drilling fluid from the sea floor. The divers, using remote hoses, will vacuum up the material pumping it through extremely fine mesh filter bags that will trap the clay-sized particles. Each bag will be recovered onto a diving support vessel, brought to shore and disposed of at an approved offsite location.

The divers shall maintain records of the quantity of drilling fluid removed, the transfer of the material to a disposal facility and the daily status of cleanup operations. The Contractor shall be responsible for disposing of the vacuumed material and waste drilling fluids according to the local, state and federal regulations.

Records or manifests of the disposal shall be furnished to the agencies upon completion of the work.

6.2 Release on Land

In the event a bentonite release occurs on land, the release will be immediately contained by using silt fencing, straw bales, sand bags or a containment pit. The drilling fluid will be transferred manually or by pump back to the drill site for reuse or into a storage tank and removed from the site.